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The Effect of Therapeutic Horseback Riding Compared to Traditional Physical Therapy on Range of Motion, Tone, Pulmonary Function, and Balance in Children with Cerebral Palsy

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THE EFFECT OF THERAPEUTIC HORSEBACK RIDING COMPARED TO TRADITIONAL PHYSICAL THERAPY ON RANGE OF MOTION, TONE, PULMONARY FUNCTION, AND BALANCE IN CHILDREN WITH CEREBRAL PALSY

by

Rene' Roze
Bachelor of Science in Physical Therapy
University of North Dakota, 1993

An Independent Study

Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Physical Therapy

Grand Forks, North Dakota
May
1994

This Independent Study, submitted by Rene' Roze in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

Eric Simonds MS, P.T.
(Faculty Preceptor)

Beverly Johnson MS, OT
(Graduate School Advisor)

Thomas Moe
(Chairperson, Physical Therapy)

PERMISSION

Title The Effect of Therapeutic Horseback Riding Compared to Traditional Physical Therapy on Range of Motion, Tone, Pulmonary Function and Balance in Children With Cerebral Palsy.

Department Physical Therapy

Degree Master of Physical Therapy

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Signature Renee Rose

Date April 24, 1994

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ABSTRACT

Therapeutic horseback riding programs have grown rapidly since 1969, when the first center opened in Michigan. Although therapeutic riding is a growing adjunctive therapy procedure, the claims that the program facilitates musculoskeletal and physiological improvements have never been objectively examined against a control group. The purpose of this independent study was to measure the effect of therapeutic horseback riding compared to traditional therapy on range of motion, pulmonary function, balance and muscle tone in children with cerebral palsy.

Twelve children underwent assessments according to the repeated measures design. Six children who received traditional therapy served as a control group, while the experimental group was compromised of six children who received therapeutic riding. Data was gathered prior to, and at the cessation of, the designated six week program. Results indicate that balance was significantly improved after the therapeutic riding sessions as compared to traditional therapy. A statistically significant decrease in bilateral hip abductor and right shoulder flexion muscle tone was also found at the conclusion of the therapeutic riding program.

Although not statistically significant, a strong trend was also noted toward increased range of motion and forced expiratory volume for children in the experimental group.

Therapeutic riding appeared to improve balance and to reduce tone in certain muscle groups for children with cerebral palsy. Further study is warranted to isolate additional variables, and examine the effects of therapeutic riding on different disabilities.

CHAPTER 1

INTRODUCTION

Therapeutic riding has recently been cited as one of the fastest growing therapy treatments for the disabled population.[1] The practice of therapeutic riding, however, is far from new. Instances of therapeutic riding have been reported since the 5th century B.C. when Greek and Roman soldiers, injured in battle, were put back on their horses for recovery purposes.[1]

Therapeutic riding centers were operating in Germany as far back as the 1600's.[2] The Germans emphasized using the horse's movement for primary therapeutic benefits as an adjunct to Bobath techniques,[3] on the basis that natural sensorimotor integration occurs secondary to the physical movements of the horse.[3,4] The aim of therapeutic riding is to provide mental, physical and social stimulation to treat the abilities as well as the disabilities of individuals with handicaps.[5]

The world's eyes first opened to therapeutic riding when Liz Hartel, of Denmark, left her wheelchair to win an Olympic silver medal for dressage in 1952. Nine years prior she was unable to walk because of polio.[1-4,6-8] Upon the

inspiration of Hartel, the first therapeutic riding centers were built during the late 1950's in Great Britain. By 1983, 540 programs were reported in Britain with 10 to 400 disabled riders in each program.[1]

North America's involvement began in 1965 in Toronto, Canada, with the Community Association for Riding for the Disabled (CARD). This program was founded by Dr. Eugene Renaud and Joseph Bauer, a horseman who attributes his recovery from hemiplegia to riding.[1,9] In 1969, the North American Riding for The Handicapped (NARHA) was established in the United States. Two of the many functions of NARHA are granting center accreditation and instructor certification.

Therapeutic riding is primarily indicated for disabilities that result in motor dysfunction. Reports suggest that it has been successfully used with patients having central nervous system deficits such as cerebral palsy, multiple sclerosis, head trauma, cerebral vascular accidents, and poliomyelitis. Patients with paraplegia, spina bifida, and postural dysfunction may also benefit from the therapeutic motion of the horse.[10]

There are established contraindications for therapeutic riding in the literature.[4,6,11] German guidelines caution against the use of the horse when there is a structural scoliosis of greater than 30 to 40 degrees.[10] Other contraindications include a marked decrease in hip range of

motion or asymmetry because this prevents the achievement of good alignment of the hips, pelvis, and spine when on the horse. The patient must demonstrate atlanto-axial stability and must be negative for the following conditions: Coxa arthrosis, arthritis, multiple sclerosis (when in the exacerbated state), severe osteoporosis, disc protrusion and seizures.[11]

The rational for therapeutic riding is based on the sound principles of neuromuscular control and coordination. These principles incorporate the theories and techniques of Rood, NDT, PNF, and Motor Systems, including error detection and motivation.

The horse's movement provides a holistic treatment approach that simultaneously moves and provides normalized, repetitive, sensorimotor input which is needed in order to develop sensorimotor control for motor relearning.[12] In traditional treatments, one therapist might be facilitating normal movement of the patient's knees, and another the hips, in order to develop walking skills. By using a horse, sensorimotor stimulation is transmitted from the horse to the rider's pelvis and trunk, giving a "repeated, rhythmical, effortless sense of an integrated organized system with many coordinated parts functioning as a whole.[14]

Deep proprioception is obtained in various postures on the horse which may include weight bearing through the upper extremities as well as through the trunk, pelvis, legs and

feet. The deep proprioception obtained in these postures enhances the development of postural stability and body awareness as the rider's body reacts to the movement of the horse.[10] The horse's trotting motions also provide the patient with proprioceptive stimulation and facilitate trunk extension.[14] It logically follows that this trunk extension promotes erect posture, thus facilitating increased pulmonary volume.

The horse imparts a precise, smooth, rhythmical pattern of movement to the rider. As the horse walks, its center of gravity is displaced three-dimensionally with a movement very similar to the action of the human pelvis during gait. Jurg Baumann, a physician with the Neuro-orthopedic Unit in Basel, Switzerland studied the similarity of pelvic movements during walking and riding and found the following measurements: rotation (combination of pelvic and lumbar) of approximately 40 degrees for a walker and approximately 35 degrees for a rider, lateral displacement of the pelvis of 5 cm for a walker and 7 cm for a rider, and a vertical displacement of the pelvis of 5 cm for both the walker and the rider.[11]

Vestibular stimulation, through changes in speed, direction, and body position, facilitates the development of righting reactions and spatial orientation. Most patients with decreased righting reactions, visual spatial or vestibular orientation, require repeated facilitation, which

the horse provides, to obtain true antigravity trunk control.[10] Although the horse's movement gives vestibular input, it rarely causes autonomic nervous system symptoms. A reasonable hypothesis for this is that the sensorimotor input from the horse's movement closely correlates with the human walk, and therefore, is not disruptive to the autonomic nervous system.[14]

With increased interest in therapeutic horseback riding has come the need for scientific research to document the significant achievements of the programs. A review of the literature revealed only three studies which investigated therapeutic riding.

A preliminary study done by Wingates in 1982 did not provide objective physical evaluation methods, but rather investigated the feasibility of implementing a horseback riding program for handicapped children that would be acceptable to them. During the 5 week therapeutic riding program, 7 subjects demonstrated successful outcomes measured in terms of the enjoyment of participants, the attendance, and the satisfactory volunteer participation. The study called for more objective measures to assess the following therapeutic outcomes which were also observed: improved posture, less falling when walking, improved head control, a decrease in lower extremity hypertonus, and improved gait with less hip and knee flexion.[15]

In 1984 Fox et al used a combination of objective

physical measures and parent/therapist interviews to investigate the efficacy of a therapeutic riding program. Nineteen children with disabilities, ages 7 to 14 years were evaluated pre and post riding. Following the typical 90-120 minute riding session, the quantification of balance and coordination required to demonstrate stability showed a 7.2% increase immediately after riding. The arm strength measurements showed an 8.1% increase following riding, while the leg strength improved 13.8%. The study stated that the range of differences in pre and post riding strength varied considerably between individual subjects, but was quite reproducible for individual subjects. Clinical impressions of the therapists and parents suggested concomitant progress in characteristics such as self-confidence and interaction with others.[16]

Bertoti's 1988 study objectively measured a significant improvement in posture of children with cerebral palsy after a ten week riding program. Eleven children with moderate to severe cerebral palsy age 2 to 9 years underwent postural assessment according to the repeated measures design. A statistically significant difference was found with improvement occurring during the period of therapeutic riding. Clinical subjective improvement were observed in the quality of muscle tone, balance, and weight bearing abilities.[4]

Neither Wingates, Fox et al, or Bertoti employed a

control group to compare therapeutic riding with conventional therapy in terms of comparing and quantifying results using objective data. In addition, the observed benefits of reduced muscle tone, increased range of motion and pulmonary function have not been previously analyzed. The purpose of this independent study is therefore to fill this void by providing objective data regarding range of motion, balance, muscle tone and pulmonary function in children with cerebral palsy after 6 weeks of a therapeutic riding program as compared to a control group receiving conventional physical therapy. This study investigated whether therapeutic riding could produce objective results and thus warrant increased utilization in the medical field.

CHAPTER 2

RATIONALE

The rationale for therapeutic riding is based on sound principles of the neuromuscular basis of controlled, coordinated activity. These principles incorporate the theories and techniques of Rood, NDT, PNF, and motor systems, including error detection and motivation.

Rood maintains that motor patterns are developed from fundamental reflex patterns present at birth. These reflexes are the basis for movement and are controlled at subcortical levels. They are utilized and gradually modified by the use of sensory stimulation until the control of movement is transformed to a cortical level.[17] For this reason, a knowledge of both the horse's and the patient's individual movement characteristics is essential when pairing horses with physically involved patient's. For the horse's movement to benefit a specific rider, the dimensions of the walking gaits must coincide. The rider's body integrates only that input which is appropriate for his or her size and muscle tone. Therefore, a small child or spastic adult could not organize the movement input provided by a long striding horse as the movement would be too foreign to integrate. The horse is not meant to impose, but

rather to provide people the ability to experience the sensations of subcortical automatic movement.[13] The patient with motor dysfunction has not experienced the normal development and reflexes that are the basis for movement at the subcortical level. The sensorimotor stimulation transmitted from the horse to the rider's pelvis and trunk, gives a "repeated, rhythmical, effortless sense of an integrated organized system with many coordinated parts functioning as a whole."[14] The rider's awareness of this input is mostly subcortical and the beneficial results are automatic.[6] Through strong, graded sensory information provided by the horse, the control of movement can be transformed to the cortical level.

The horse imparts strong, graded sensory stimulation in the form of tactile, proprioceptive and vestibular input.[13] Tactile, hyper- or hypo- sensitivity can be normalized by the warmth of the horse, heavy touch-pressure and weight shifting. Deep proprioception is obtained in various postures on the horse, which may include weight bearing through the upper extremities as well as through the trunk, pelvis, legs and feet. The deep proprioception obtained in these postures facilitates the development of postural stability and body awareness.[10] For example, hemiplegic riders benefit from riding in circles with the affected side toward the center of the ring. This increases the proprioceptive input and weight bearing on the involved limb

due to the natural weight shift in both the horse and the rider.[6] Postural asymmetries can be treated in the same way by having the horse walk on a hill.[19]

When neurologic systems disrupt a patient's ability to coordinate things bilaterally, and execute motor planning, they will often respond to therapeutic horseback riding based on the principles of Sensory Integration.[20] This can be credited to the skill and performance required to accommodate body responses (coordinating sensory input, motor output, and sensory feedback) and verbal commands for therapeutic riding.[6]

Proprioceptive neuromuscular facilitation (PNF) techniques are methods promoting or hastening the response of the neuromuscular system through stimulation of proprioceptors. This technique recommends that the therapist treat the whole body, and ascertains that movement is learned through the sensation of movement. The facilitory techniques of manual contact, stretch, approximation, traction, normal timing and rhythmic initiation are all inherent in the therapeutic riding program. Progression of the riding program can be sequenced according to the developmental progression and the stages of motor control that are described as mobility, stability, controlled mobility and skill.

Mobility can first be obtained through rhythmic initiation by passively using the movements of the horse.

One treatment technique calls for the child to lie prone while the therapist mobilizes the pelvis or shoulder and scapula as the horse's slow movement induces relaxation.[4,21] Stability is induced with rhythmic stabilization of the pelvis occurring secondary to the co-contraction of the obliques, abdominals and trunk extensor musculature. Stability is also induced in the hip and knee joints with co-contraction of the quadriceps and the hamstrings. The riding program is then progressed to the rider executing controlled mobility and skilled activity. Gradually, the difficulty of the exercises and the speed of the horse are increased, and finally, the rider is able to participate independently in skilled maneuvers and organized games.

The conventional neurodevelopmental treatment (NDT), approach maintains that trunk alignment and mobilization precedes limb function. NDT treatment techniques also stress that a prime prerequisite for treatment is to "normalize" tone before attempting active motion.[8] It is challenging to influence positive changes in the trunk using traditional therapy techniques. By using the horse's movement, repetitive symmetrical input is transferred to the patient's trunk. This movement mobilizes the pelvis, lumbar spine and hip joints.[4] Slow, sinuous movements, together with the warmth of the hose is useful in reducing abnormally high muscle tone.[21] The patient's positioning on the horse itself relaxes the lower extremity extension synergy pattern

because the legs are externally rotated, abducted, and the feet are dorsiflexed. The posture, if the rider is carefully positioned on the horse, inhibits and relaxes unwanted reflexes. For example, pressure of the stirrup on the sole of the foot does not elicit a positive supporting reflex while the hip is held in flexion and abduction by the saddle.[6]

Motor systems theoretical constructs ascertain that characteristics of motor control include: 1) ability to assess the demands of a task, predict needs and organize appropriate responses, 2) actions must be trained as they occur in functional tasks, 3) ability to identify the difference between the intended movement and what actually happens (error detection) and 4) must have adaptive capability that allows change for detected errors. Motor systems theorizes that control systems are composed of open and closed loops. An open loop being "feedforward" with movement execution relying entirely on central programming. A closed loop or "feedback" control involves the use of sensory feedback to guide movement.[22]

Therapeutic riding provides feedback loops of activity by using multiple sensory feedback mechanisms. As the rider anticipates needs and organizes appropriate responses, open loop control is enhanced. Task specificity is utilized during therapeutic riding in that the movement of the rider's pelvis so closely correlates with the movement of a

walker.[15] The postural trunk muscles are trained in a task specific manner, through repetitive normalized input from the horse. The rider must develop balance to compensate for movement of the horse. The balancing skills required in horsemanship improve postural alignment in all activities and also allow for immediate error detection.[6]

Motor systems model maintains that control resides in the system as a whole, and in the dynamic interaction of sensory, cognitive perception, muscle control and central nervous system coordination, with only motivation as a superior determinant.[22] Horseback riding demands dynamic interaction of all these systems and is innately motivating. Reports claim therapeutic riding enhances rider's ability to respond to a variety of sensory stimuli, because sensory information from the tactile, auditory, visual, skeletal, and vestibular systems must be integrated in order to produce the necessary body responses and verbal commands for riding.[6]

This study investigated if the theory of therapeutic riding produced objective improvements in muscle tone, pulmonary function, balance and range of motion as compared to a conventional therapy treatment.

CHAPTER 3

METHODS

SUBJECTS

Six children diagnosed with cerebral palsy served as an experimental group receiving therapeutic riding. This group consisted of four boys and two girls from the ages of 53 to 106 months (X=78.3 months;s=27.54). The children were recruited from Rocky Top Therapy Center, a facility specializing in therapeutic riding (660 Ottinger Road, Keller, TX).

The control group received traditional therapy and consisted of six children: four girls and two boys from the ages of 32 to 73 months (X=46.83; s=14.98) recruited from The Well Mill Physical Therapy Clinic (5701 Westcreek, Fort Worth, TX).

The diagnostic distribution for both groups was homogeneous, as each group had three children with spastic paraplegia and three children with spastic quadriplegia. All subjects were recruited in accordance with the policies set by the University of North Dakota's Institutional Review Board (Appendix A). Physician referrals and consent statements from each child's parent were obtained prior to the study (Appendix B).

The following inclusion criteria were developed to screen prospective subjects: 1) medical diagnosis of cerebral palsy, spastic quadriplegia or paraplegia, 2) passive hip abduction to at least 20 degrees bilaterally as measured in the supine position, 3) passive hip flexion to at least 60 degrees by a straight leg test, and 4) atlanto-axial stability.

INSTRUMENTATION

The Modified Ashworth Scale of Muscle Spasticity, which has documented reliability and validity,[23] was selected to analyze changes in muscle tone of the upper and lower extremities. Subjects were assessed in supine and prone by passively moving the upper and lower extremities through the full available range of motion over a duration of about two seconds (by counting one thousand one, one thousand two). See appendix C for evaluation form and measurement scales.

Range of motion was assessed by measuring the passive movement of the upper and lower extremities with a universal plastic goniometer while the subjects were in supine. Good interrater reliability for the universal goniometer as a measurement tool in assessing cerebral palsy has been documented.[24]

A timed measurement of sitting balance was used to assess changes in balance reactions. Subjects were positioned in short sitting, feet unsupported, and hands on hips. Timing started as soon as the subjects were

unsupported in the above position, and was stopped when any part of their upper extremity touched the mat. Subject were scored two times and the best performance was recorded in order to reflect optimal performance. An ordinal value was assigned to timed sitting balance (appendix C). A similar test has exhibited good interrater reliability.[25]

Pulmonary function was assessed using a Micro Spirometer (P.O. Box 6, Rochester, Kent MEI 2AZ England) to measure forced expiratory volume. Pulmonary readings could not be obtained for four of the subjects because of the 1-inch diameter of the disposable cardboard mouthpieces, and the cognitive level of the subjects precluded successful collection of FEV values.

Each subject was positioned in short sitting, feet supported, pelvis in neutral, and trunk in an upright midline position. A practice reading was performed with two readings recorded. Again, only the highest readings were analyzed to reflect optimal performance secondary to poor first trial scores. The repeatability of measurements and the validity between the Micro Spirometer and the Vitalograph have been documented.[26]

PROCEDURE

A repeated measures design consisting of a pretest and a postest was implemented. The children in each group participated in therapy two to three times a week for one hour sessions over a six week period. The programs were

progressed according to individualized assessment and goals.

Each riding session stressed decreasing postural compensations, increasing muscle flexibility, active co-contraction and facilitating equilibrium reactions. Children were instructed in heel raises, upper extremity range of motion and strengthening exercises while performing grooming activities. Exercises were first performed on a stationary horse and then movement and speed were introduced. The following are examples of some typical exercises performed on the horse:

1. Co-contraction and weight shift through the upper extremities while in an extended arm "prop" position
2. Active stretch to the horse's ears and tail
3. Stretch to the child's toes and knees
4. Trunk rotation stretch performed while holding a bar with both hands and rotating right then left
5. Shoulder flexion and extension performed with the bar
6. Squat position to encourage lower extremity strengthening and active weight shifting while maintaining a stretch to the gastroch muscle
7. Abdominal strengthening activities by extending the trunk backward and arms extending forward
8. The horse was led in circles or in a serpentine fashion to challenge and to strengthen the desired

muscles.

Skilled activities such as placing a ring on a stationary pole while the horse was walking and completing activities at different speeds were also part of the program. Motor planning activities included reining the horse through patterns and obstacles.

The children in the control group participated in similar therapeutic exercises utilizing modalities that were available in the clinical setting (ie. swiss balls and mat exercises).

DATA ANALYSIS

Range of motion was analyzed using an independent t-test to determine whether a significant change existed between the control and experimental group.[27] A Mann Whitney U test was used to determine whether a significant change in tone or balance existed between the two groups. This test was chosen because the data was ordinal and therefore non parametric. Pulmonary volume was not statistically analyzed because measurements were unable to be obtained from 5 subjects.

CHAPTER 4

RESULTS

The results of the Mann Whitney U test for balance and tone are summarized in Table 1. These results show that balance was significantly improved after the therapeutic riding as compared to the traditional therapy. A reduction in muscle tone during bilateral hip abduction and right shoulder flexion was also statistically significant for the experimental group. Although other measures of muscle tone were nonsignificant, the experimental group generally demonstrated a greater decrease in tone reduction for all motions.

Although nonsignificant, the experimental group demonstrated a strong trend toward improved range of motion measurements in the following bilateral movements: shoulder extension, hip flexion, hip adduction, and planter flexion. These results are summarized in Table 2.

Raw composite scores for forced expiratory volume (FEV) are presented in Table 3. Statistical analysis could not be completed on this data since values were only recorded for eight out of the twelve subjects. Each child in the experimental group showed an increase in pulmonary capacity, whereas only one child in the control group increased in FEV

during postest assessment. Many subjective clinical improvements, for language skills, strength, weight shifting, posture, and initiating motion from the pelvis were also observed.

Table 1. Mann Whitney U test values for balance and tone results between Group 1 (control), and Group 2 (experimental).

	x	u	p
BALANCE			
Group 1	4.17	4	.0260
Group 2	8.83		
TONE			
Shldr flx R			
Group 1	9.00	3	.0152
Group 2	4.00		
Hip abd R			
Group 1	9.00	3	.0152
Group 2	4.00		
Hip abd L			
Group 1	9.00	3	.0152
Group 2	4.00		

Table 2. T test values for ROM results between Group 1 (Conrol) and Group 2 (experimental)

	x	s	t	df	p
R Shldr ext					
Group 1	1.333	6.408			
Group 2	13.833	17.256	-1.66	6.35	.145
L Shldr ext					
Group 1	2.833	7.441	-1.00	6.08	.356
Group 2	12.508	22.519			
L Hip flx					
Group 1	2.833	13.333	-1.85	10	.320
Group 2	10.833	13.121			
R Hip flx					
Group 1	6.500	15.043	-1.04	10	.322
Group 2	13.833	8.448			
L Hip add					
Group 1	.167	1.835	-1.76	5.74	.131
Group 2	5.167	6.706			
R Hip add					
Group 1	.833	1.329	-1.25	5.61	.261
Group 2	3.667	5.391			
R Plntr flx					
Group 1	2.533	7.688	-1.29	10	.225
Group 2	9.167	10.008			
L Plntr flx					
Group 1	1.667	7.441	-1.33	10	.212
Group 2	9.500	15.463			

* α=.05, two tailed test, t=2.28 ■ pooled variance estimate
  α=.05, two tailed test, t=2.44 ■ separate variance estimate

Table 3. Raw FEV values reported in ml for control (group 1), and experimental group (group 2).

GROUP 1			GROUP 2		
n	PRE RX	POST RX	n	PRE RX	POST RX
1	0	0	1	.63	.88
2	.38	.42	2	.45	.55
3	0	0	3	.40	.52
4	.68	.69	4	1.03	1.24
5	0	0	5	1.26	1.29
6	.60	.58	6	0	0

CHAPTER 5

DISCUSSION

This study documented statistically significant improvement in balance for children participating in the therapeutic riding program when compared to children receiving traditional therapy. These results correlated with Fox et al who reported an increase in balance and coordination and with Bertoti who showed improved postural control following ten weeks of therapeutic riding.[16]

Improvements in sitting balance were evidenced by an increased ability to right the trunk in all directions after minimal to moderate displacement. All 6 children in the experimental group demonstrated some improvement in balance, as noted by a longer duration for independent sitting. Only two of the six children in the control group showed improvement in their sitting balance. Sensory input from the movement of the horse to the vestibular system, as well as approximation through the spine, may have facilitated trunk stability and improved equilibrium reactions.

The significant decrease in right shoulder flexion tone of the children in the therapeutic riding group may be associated with the increased shoulder extension range or with the right hand dominance (83%) exhibited by this group.

Bilateral hip abductor tone also was significantly reduced in the therapeutic riding group, and within the concept of musculoskeletal balance, may account for the trend toward increased hip adduction movement noted in this group. No other investigators have formally explored the effects of therapeutic riding on muscle tone.

Although pulmonary function could not be statistically analyzed, the raw data revealed that each child in the experimental group made greater improvements than the control group. By facilitating improved posture, as found by Bertoti[4], treatment on a dynamic base (the horse) would theoretically increase lung capacity. The raw FEV values confirmed this theory, but require further investigation to statistically validate the results.

The experimental group demonstrated a consistent, but nonsignificant, increase in bilateral range of motion for shoulder extension, hip flexion, hip adduction and plantar flexion as compared to the control group. This could be the result of active bilateral range of motion activities while on the horse. For example, by sitting upright and riding with the shoulders extended and hands in ulnar deviation on the back of the horse, the shoulder capsule is mobilized anteriorly while in a weight bearing position. This may account for the increase in bilateral shoulder extension.

Potential confounding variable for this study were the small sample size, the brief 6 week intervention, and the

inability to collect FEV values on all subjects. However, numerous subjective improvements were observed in trunk strength, weight shifting and rotational skills in the experimental group. These observations were consistent with the development of proximal motor control as the movement of the horse provided dynamic antigravity resistance to the trunk. NDT constructs ascertain that improvements in trunk motion must precede improvements in extremity motions. This may be expected when acquiring increased control along a cephalocaudal sequence.[28]

This study demonstrated that riding can be a valuable therapeutic modality for children with spastic cerebral palsy. A riding program can be beneficial when it is carefully structured, after a thorough evaluation, with specific therapeutic activities chosen to facilitate achievement of therapeutic goals. Riding offers the therapist a dynamic treatment base to influence trunk antigravity control and to provide a variety of upper and lower extremity weight bearing positions. Therapeutic riding also allows the movement of the rider to begin at the pelvis around his or her center of gravity. This is critical, since most gross motor movement should be initiated at the pelvic region. The horse is a versatile therapeutic medium and affords the opportunity to perform joint mobilization, muscle stretching, equilibrium reactions and muscle strengthening activities with the added motivation of

horseback riding.

This study constitutes a small step in examining and in documenting some of the proposed therapeutic effects of horseback riding compared to traditional therapy during the treatment of individuals with disabilities. Further study is needed to explore the effects of therapeutic riding on trunk range of motion and control, gait analysis, strength, and functional mobility. In addition to children with cerebral palsy, therapeutic riding centers serve clients with multiple sclerosis, hemiplegia, Down's syndrome, spinal cord injuries, and traumatic brain injuries. Future studies are needed to focus on therapeutic horseback riding as it affects these patient populations, as well as, the previously mentioned subjective improvements.

CHAPTER 6

CONCLUSION

The results of this study constitute the first objective analysis of a therapeutic riding treatment program compared to conventional treatment for children with cerebral palsy. The results show that a statistically significant improvement in balance was noted in the therapeutic riding group compared to the conventional treatment group. A significant decrease in bilateral hip abduction tone and right shoulder flexion tone was also found. A strong trend was present for the experimental group to have greater improvements in bilateral hip flexion, shoulder extension, hip adduction and planter flexion motions. Further study is needed to isolate additional variables and to examine the effects of therapeutic riding on different disabilities.

APPENDIX A

__EXPEDITED REVIEW REQUESTED UNDER ITEM _____ (NUMBER[S]) OF HHS REGULATIONS
__EXEMPT REVIEW REQUESTED UNDER ITEM _____ (NUMBER[S]) OF HHS REGULATIONS

UNIVERSITY OF NORTH DAKOTA
HUMAN SUBJECTS REVIEW FORM
FOR NEW PROJECTS OR PROCEDURAL REVISIONS TO APPROVED PROJECTS INVOLVING HUMAN SUBJECTS

CIPAL
STIGATOR: Rene Roze TELEPHONE: 701-777-2831 DATE: May 24, 1993

ESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT: UND-PT, Box 9037, Grand Forks, ND 58202-9037

OL/COLLEGE: University of North Dakota DEPARTMENT: Physical Therapy PROPOSED PROJECT DATES: January-May, 1994

ECT TITLE: The Effect of Therapeutic Horseback Riding on Posture, Range of Motion, Cardiopulmonary Function and Balance Children With Cerebral Palsy

ING AGENCIES (IF APPLICABLE): _____

OF PROJECT:
_ NEW PROJECT _____ CONTINUATION _____ RENEWAL _____ DISSERTATION OR THESIS RESEARCH __X__ STUDENT RESEARCH PROJECT
_ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

ERTATION/THESIS ADVISER, OR STUDENT ADVISER: Erin Simunds

OSED PROJECT: _____ INVOLVES NEW DRUGS (IND) _____ INVOLVES NON-APPROVED USE OF DRUG __X__ INVOLVES A COOPERATING INSTITUTION

NY OF YOUR SUBJECTS FALL IN ANY OF THE FOLLOWING CLASSIFICATIONS, PLEASE INDICATE THE CLASSIFICATION(S):

MINORS (<18 YEARS) ___ PREGNANT WOMEN ___ MENTALLY DISABLED ___ FETUSES ___ MENTALLY RETARDED

PRISONERS ___ ABORTUSES ___ UND STUDENTS (>18 YEARS)

OUR PROJECT INVOLVES ANY HUMAN TISSUE, BODY FLUIDS, PATHOLOGICAL SPECIMENS, DONATED ORGANS, FETAL MATERIAL, OR PLACENTAL IALS, CHECK HERE _____

BSTRACT: (LIMIT TO 200 WORDS OR LESS AND INCLUDE JUSTIFICATION OR NECESSITY FOR USING HUMAN SUBJECTS.

Therapeutic horseback riding programs have grown rapidly since 1969, when the first center opened in Michigan.[1] Today, there are 450 centers in the United States alone.[2] Although therapeutic riding is a growing adjunctive therapy procedure, there has been only one objective study undertaken to document the program's proposed effect for facilitating postural improvement. The claims that the program facilitates joint stability, range of motion, normalized muscle tone, postural and equilibrium responses have never been objectively documented.

The purpose of this independent study is to measure range of motion, posture, muscle tone, balance and cardiopulmonary function in children with spastic cerebral palsy after participating in a therapeutic horseback riding program. Twenty children with moderate to severe spastic CP, aged 5 to 18 years, will undergo assessments according tot he repeated measures design. Ten children will be randomly assigned to a control group. Data will be gathered prior to the initiation of the therapeutic riding program and within two weeks after the cessation of the program. Results will be analyzed using a t-test for two related samples with all interval ratio data (ROM, balance, cardiopulmonary function). The Wilcoxon Matched Pairs Signed ranks test will be used to analyze posture and muscle tone.

ASE NOTE: Only information pertinent to your request to utilize human subjects in your project or activity should be included on this form. Where appropriate attach sections from your proposal (if seeking outside funding).

PROTOCOL: (Describe procedures to which humans will be subjected. Use additional pages if necessary.)

Subjects: Twenty children with cerebral palsy ranging in age from 5 to 18 years will be selected from Rocky Top Therapy Center in Keller, Texas, to participate in this study. This is a comprehensive rehabilitation center for physically challenged individuals with licensed physical, occupation, and speech therapists on staff. Physician referrals and consent statements from each child's parents will be obtained. Ten children will be randomly selected to serve as a control group receiving traditional physical therapy treatment in a clinical setting, while the other ten children will participate in a nine-week riding program.

Inclusion criteria for the study include the following: 1) medical diagnosis of CP, spastic quadriplegia or diplegia, 2) no other medical complications such as seizures or hydrocephalus, 3) normal intelligence as documented by a psychologist, 4) normal spine and hip x-rays, 5) passive hip abduction to at least 20 degrees bilaterally as measured in the supine position, 6) passive hip flexion to at least 60 by a straight leg test, 7) functional ability to sit and stand alone or with minimal support.

Experimental Design: A repeated measures design consisting of a pretest, followed by a nine-week therapeutic riding program and a post-test will be implemented for the experimental group. The control group will be measured before and after conventional clinical treatment.

Procedure: Range of motion will be assessed passively with the child in supine using a goniometer. Good reliability for goniometric measurements of children with spastic quadriplegia has been demonstrated.[3]

Posture assessment will be conducted with girls wearing halter tops and shorts and the boys wearing shorts. The children are to stand as they normally would. Manual assistance for children needing support is to be given by supporting the pelvis from the front. Posture Evaluation will be conducted using Bertoti's Assessment Scale to rate observable qualities of postural control and symmetry on a 0 to 3 scale. Five pediatric physical therapists who used the scalae had judged it to be a valid measure of posture for CP children.[4] This posture assessment scale scores the alignment and symmetry of five body areas: 1) head and neck, 2) shoulder and scapula, 3) trunk, 4) spine, and 5) pelvis.

Muscle tone will be assessed using a modified Ashworth scale. The child will be measured in supine by passively moving the upper and lower extremities through five repetitions of movement with several minutes separating each blind rating. Again, good reliability was found for this scale.[5]

A balance test measuring time and quality of balance on one leg will be assessed. The interrater and test-retest reliability using Spearman Coefficients were found to range from moderate to high.[6]

Cardiopulmonary function will be assessed using an incentive spirometer to measure forced expiratory volume.

BENEFITS: (Describe the benefits to the individual or society.)

A large portion of pediatric physical therapy caseload is cerebral palsy. The goal of physical therapy is to decrease abnormal patterns of movement, improve equilibrium, coordination, head and trunk control. Since CP is a chronic disability, it often requires children to be involved in therapeutic activities for a number of years. This becomes a challenge for the physical therapist to maintain the child's interest and stimulate motivation. This study will scientifically investigate some of the proposed effects of therapeutic riding that have never been evaluated.

The conventional Neurodevelopmental Treatment approach teaches that trunk alignment and mobilization precedes limb function. It is challenging to influence positive changes in the trunk using traditional therapy techniques. By using the horse's movement, repetitive symmetrical input is transferred to the patient's trunk. This movement mobilizes the pelvis, lumbar spine, and hip joints. The rider's pelvis is displaced three-dimensionally with a movement very similar to the action of the human pelvis during gait. The repetitive input provides the brain with neurosensory information necessary for motor relearning. While riding, the person's righting and equilibrium responses are also facilitated.

Tremendous psychological benefits are associated with the riding setting and interaction with the horse.

RISKS: (Describe the risks to the subject and precautions that will be taken to minimize them. The concept of risk goes beyond physical risk and includes risks to the subject's dignity and self-respect, as well as psycho-logical, emotional or behavioral risk. If data are collected which could prove harmful or embarrassing to the subject if associated with him or her, then describe the methods to be used to insure the confidentiality of data obtained, including plans for final disposition or destruction, debriefing procedures, etc.)

The risks involved include those normally associated with horseback riding. Each rider will wear a helmet and a gait belt to protect against falling. Two people will walk on either side of the horse during the program and, if needed, a backrider will also be used to give additional support.

The following safety adaptations will be used as necessary: 1) handholds to help the beginning student maintain his balance and give the child different handhold positions, 2) bit leads to allow the side walkers to affect the pony in the same way as does pressure on the reins, 3) safety stirrups that will quickly release the foot from the stirrup in case of a fall, 4) overhead checks to keep the pony from reaching down to ground level which could cause an unbalanced student who is holding the reins to be pulled forward, 5) fleece saddle covers to help prevent sores from developing.

A mounting ramp will be used to safety lift some of the children from ground level to the back of the horse. The children will be introduced to the horse prior to treatment and will participate in the program only in the absence of unavoidable anxiety.

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CONSENT FORM: A copy of the **CONSENT FORM** to be signed by the subject (if applicable) and/or any statement to be read to the subject should be attached to this form. If no **CONSENT FORM** is to be used, document the procedures to be used to assure that infringement upon the subject's rights will not occur.

Describe where signed consent forms will be kept and for what period of time.

For **FULL IRB REVIEW** forward a signed original and thirteen (13) copies of this completed form, and where applicable, thirteen (13) copies of the proposed consent form, questionnaires, etc. and any supporting documentation to:

Office of Research & Program Development
University of North Dakota
Box 8138, University Station
Grand Forks, North Dakota 58202

On campus, mail to: Office of Research & Program Development, Box 134, or drop it off at Room 101 Twamley Hall.

For **EXEMPT** or **EXPEDITED REVIEW** forward a signed original and a copy of the consent form, questionnaires, etc. and any supporting documentation to one of the addresses above.

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olicies and procedures on Use of Human Subjects of the University of North Dakota apply to all activities involving use of Subjects performed by personnel conducting such activities under the auspices of the University. No activities are to be ated without prior review and approval as prescribed by the University's policies and procedures governing the use of human cts.

TURES:

[signature] **DATE:** 11-22-93
ıpal Investigator

[signature] MS, P.T. **DATE:** 11-22-93
ct Director or Student Adviser

[signature], Director **DATE:** 6-15-93
ıng or Center Grant Director
ıcky Top Therapy Center

(Revised 8/1992)

APPENDIX B

THE EFFECT OF THERAPEUTIC HORSEBACK RIDING COMPARED TO TRADITIONAL PHYSICAL THERAPY

CONSENT FORM

Name of researcher: Rene' Roze, graduate student-University of North Dakota

_____ is invited to participate
(name of child)
in a research study on the effect of therapeutic horseback riding on children with cerebral palsy. The purpose of the study is to see if therapeutic horseback riding will improve clients' joint range of motion, balance, lung capacity, and muscle flexibility as compared to traditional physical therapy treatments.

Your child will be assessed in four areas taking approximately fifteen minutes, once before and once after the treatment program. The children in the therapeutic riding program will meet two times a week for eight weeks at Rocky Top Therapy Center (660 Ottinger Rd., Keller, Texas). The traditional physical therapy group will receive therapy from The Well Mill (4296 Western Center Blvd. Fort Worth, Texas) and will also meet two times a week.

Joint flexibility will be assessed passively while the child lies on his/her back.

Balance will be assessed by measuring time and quality of balance on one leg. If child is unable to stand independently, sitting balance will be timed and measured.

Pulmonary function will be assessed by having the child take a deep breath and expire into an incentive spirometer.

Muscle flexibility will be assessed with the child on his/her back and moving the upper and lower extremities through three repetitions of movement.

Participation is entirely voluntary and you have the right to withdraw consent and discontinue participation in the study at any time without prejudice to present or future care at Rocky Top Therapy Center, or at The Well Mill. There is no cost for the study, but the treatment costs will coincide with each facilities treatment session charges.

In order to reduce the risk of any injury during therapeutic

riding, two side walkers, a back rider on the horse if needed, a riding instructor, and the physical therapist will be present.
A horse is carefully selected and several pieces of adaptive equipment have been developed to decrease any risk of injury.

The reported benefits of therapeutic riding include mental, physical, and social stimulation to sustain your child's interest while promoting joint stability, weight shifting, muscle strengthening and stretching. The control group, which receives traditional physical therapy, will receive the benefits inherent in the individual treatment plans.

Information from this study will be anonymously coded to ensure confidentiality. Signed consent forms will be kept at Rocky Top Therapy Center for the duration of the treatment program and then at the University of North Dakota Department of Physical Therapy, P.O. Box 9037, Grand Forks, ND 58202-9037. Parents will be given a copy of the consent form.

Rene' Roze, Carolyn Cebul, and Sandy Seawell will be available to answer any questions you have concerning this program. You are encouraged to ask questions at any time. Questions may be asked by calling Rocky Top Therapy Center at 817-431-9403, or The Well Mill at 817-232-3062.

As parent/guardian I give permission for the above named child to participate in the research study described. My current questions have been answered and I am encouraged to ask any further questions regarding this study.

SIGNED:

_____ _____
Parent or Guardian Date

_____ _____
Principle Researcher Date

_____ _____
Witness Date

APPENDIX C

RESEARCH EVALUATION FORM

PATIENT:_____ DIAGNOSIS:_____
DOB:_____ PROGRAM:_____

BALANCE: **sitting, feet not supported and hands on hips.**

DATE

TRIAL #1	
TRIAL #2	

DATE

TRIAL #1	
TRIAL #2	

FEV

DATE

TRIAL #1	
TRIAL #2	

DATE

TRIAL #1	
TRIAL #2	

MODIFIED ASHWORTH SCALE FOR GRADING SPASTICITY

GRADE	DESCRIPTION
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motivation when the affected part is moved in flexion or extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder of the ROM
2	More marked increase in muscle tone through most of the ROM, but affected part easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part rigid in flexion or extension

TIMED SITTING BALANCE SCALE

GRADE	DESCRIPTION
4	Able to sit 5 minutes plus
3	Able to sit 1-5 minutes
2	Able to sit 30-60 seconds
1	Able to sit 1-30 seconds
0	Unable to sit independently

ROM

SHOULDER

	DATE: _____				DATE: _____			
	ROM		**TONE**		**ROM**		**TONE**	
	L	R	L	R	L	R	L	R
EXTENSION 0-45								
FLEXION 0-180								
ADDUCTION 0								
ABDUCTION 0-180								
INT. ROTATION 0-90								
EXT. ROTATION 0-90								

ELBOW

EXTENSION 0								
FLEXION 0-145								

FOREARM

SUPINATION 0-90								
PRONATION 0-90								

WRIST

EXTENSION 0-70								
FLEXION 0-80								
ULNAR DEVIATION 0-45								
RADIAL DEVIATION 0-20								

HIP

FLEXION 0-125								
EXTENSION 0-10								
ADDUCTION 0								
ABDUCTION 0-45								
INT. ROTATION 0-45								
EXT. ROTATION 0-45								

DATE_____ DATE_____

KNEE

	ROM L	ROM R	TONE L	TONE R	ROM L	ROM R	TONE L	TONE R
EXTENSION 0								
FLEXION 0-140								

ANKLE

PLANTAR FLEXION 0-45								
DORSI FLEXION 0-20								

FOOT

INVERSION 0-40								
EVERSION 0-20								

OBSERVATIONS/OTHER:

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